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WOODWORK FOR BEGINNERS

GRIFFITH

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WOODWORK FOR BEGINNERS

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PREFACE

This Book has been written in the hope that it may be of service in those grammar schools where a more extended treatment of subject-matter, such as that contained in the author's *Essentials of Woodworking*, is not possible of utilization to an extent sufficient to warrant its adoption as an individual text.

The average time presupposed for the accomplishment of the subject-matter contained herein, with its efficient application in the form of projects or models, is from one to three hours a week for a period of two years, or its equivalent. One-third of this time may well be devoted to correlated mechanical drawing.

With the limited time at the student's disposal as presupposed in this text, there is hardly time for any study of related informational matter, such as trees and tree growth. Then, too, in many schools such subject-matter is efficiently treated in the classes in nature study, or should be.

The teacher desiring an outline of a course in woodwork with drawings of possible projects suitable for grammar grades is referred to the author's *Correlated Courses in Woodwork and Mechanical Drawing*.

Assignment of text for study should be by sections, as they relate to the shopwork being done, rather than by page sequence.

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WOODWORK FOR BEGINNERS

CHAPTER I

Lumber Terms; Working Drawings; Estimating Stock

1. Lumber Terms.— Every boy who has had to cut kindling knows that wood will split when struck along the general direction of its growth. The fibers separate easily, Fig. 1. "Grain" is a term used to designate the direction of the fibers; "along the grain" means in the general direction of growth. "Length" in woodwork has reference to that direction in which the wood splits easiest; that is, along the grain. A board might therefore, be wider than it is long. Fig. 2 will make clear the meanings of other terms commonly used.

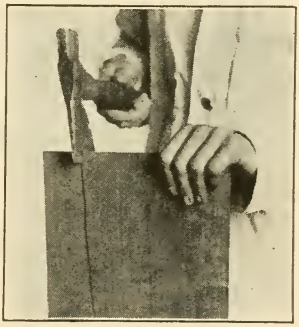


Fig. 1. Splits Easiest Along the Grain

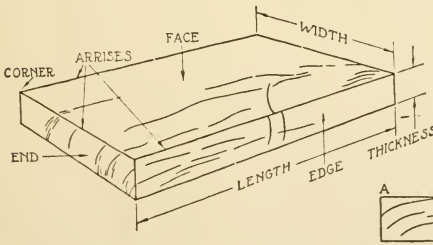


Fig. 2. Common Terms Illustrated

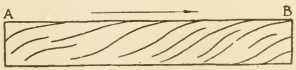


Fig. 3. Direction of Surface Grain

In planing, a surface will sometimes be roughened instead of smoothed; this is called working "against the grain." Fig. 3 shows the reason for the roughening; the remedy consists in changing the direction of the planing, or of the board.

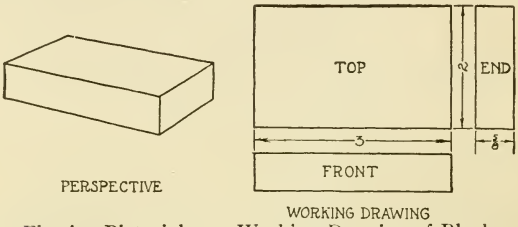


Fig. 4. Pictorial vs. Working Drawing of Block

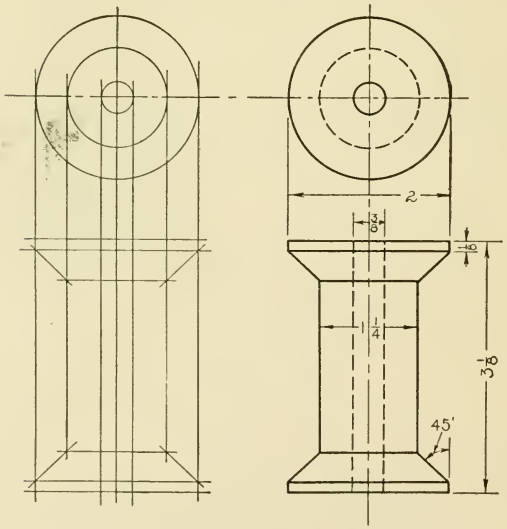


Fig. 5. Working Drawing of Wood Spool

2. Working Drawings.— Drawings are, in general, of two kinds, pictorial and working. A pictorial draw-

ing represents an object as it appears, while a working drawing represents the object as it really is, Fig. 4. The latter is of the utmost importance to the workman for it tells him concisely all about the object,— its size, shape, kind of material, etc.

Fig. 5 shows two views of a common wood spool. The front view is the view one would get by looking at the object from the front; the side view, the view one

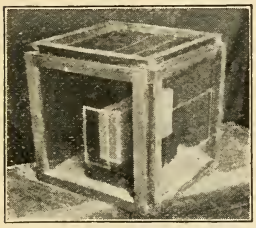


Fig. 6. Mechanical Drawing Cage

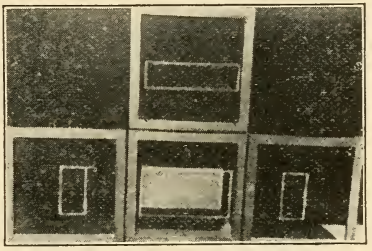


Fig. 7. Cage Unfolded

would get by looking at the side of the object; a top view, the view one would get by looking at the top of the object, the observer in each case being so far away from the object that the views show the real shape of the object and not its perspective. The side view will be found at the side of the front view and the top view will be found directly above the front view. An examination of Figs. 6 and 7 should enable one to fix the relationship of the views in mind. Fig. 6 represents an object within a "cage" where the views have been drawn upon transparent screens. Fig. 7 shows the cage as it opens out so as to bring all of the views in one plane, as they must be on drawing paper.

The various kinds of lines in a working drawing have different meanings. The very light lines of indefinite length are known as construction, extension, or projection lines. They are the first lines drawn. The heavy lines represent visible edges or outlines of the object. The broken or dotted lines represent hidden edges or outlines. Those lines having arrow barbs and numbers are known as dimension lines, and the barbs

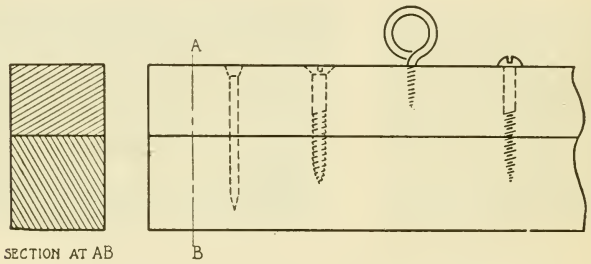


Fig. 8. Drafting Conventions

indicate the extreme limit of the measurement while the number indicates the amount. Lines through the middle of an object dividing it into two equal parts are known as center lines.

Fig. 8 shows how nails and screws may be represented. This illustration also shows two other conventions, the cross-section and the broken view. A cross-section represents an object as it would appear if cut, and is indicated by a shading, known as cross-hatching, as shown. A broken view is used when, for any reason it is not advisable or possible to represent the full view. Irregular lines indicate the missing part and the dimensions indicate the true size.

Small objects are drawn full size, that is, the object and drawing are of the same dimensions. A drawing is said to be drawn to scale when its parts are similar in proportion to that of the object it represents. There are various scales used, such as $\frac{1}{4}'' = 1'$ ($\frac{1}{4}$ inch = 1 foot); $3'' = 1'$, known as a quarter scale; and on very small objects we may have such scales as $\frac{1}{2}'' = 1''$, etc. Whatever the scale used, the figure on the drawing represents the size of the object's corresponding part.

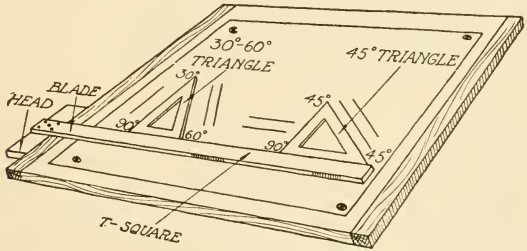


Fig. 9. Drafting Tools

Working drawings are best made with instruments. Fig. 9 shows a set. The T-square is used in making horizontal lines, the lines being drawn from left to right. The triangles are used in the making of vertical and oblique lines, the lines being drawn from the T-square upward.

3. Stock Bill.— A good workman will prepare from his working drawing a stock bill. Fig. 10 is an example of a form used by one large company. Teacher and pupil are referred to *Projects for Beginning Woodwork and Mechanical Drawing*, a companion book, pages 16–21, for a detailed description of how to make and

figure simple projects such as are usually made in elementary manual training work.

Example of Form for Bill of Materials

Ticket or Catalog Number	No. of Feet	No. of Pieces	Size	L'gth	Description	Price					
						Rate		Extensions			
	270	30	2x4	14	Yellow pine, S I S and I E	22		6	94		
		2	M		5-2″ Red Cedar Shingles.	3	55	7	10		
	300	1x6			No. 2 Y. P. flooring	20		6	00	20	04

Fig. 10. Stock Bill Form.

CHAPTER II

Laying-out Tools; Their Uses

4. The Rule.— There are various styles of rules. Whatever the style the unit of measurement is the foot

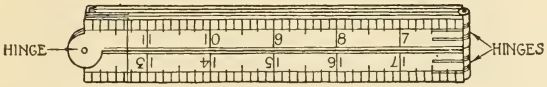


Fig. 11. Rule

with its subdivisions into halves, quarters, eighths, and in some instances sixteenths. Fig. 11.

5. Pencil and Knife.— A knife is used to lay out work that must be quite accurate, such as joints. Where

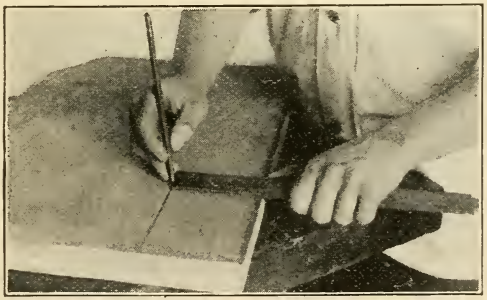


Fig. 12. Thumb-gaging Width

accuracy is not so important a pencil may be used. Pencil lines should be made with a well sharpened lead,

however. A good rule to observe in bench woodwork is: Use a knife and gage for laying out except where a finished surface would be permanently injured.

Figs. 12 and 13 illustrate two ways of marking a board to width roughly, preparatory to rough sawing. Where

Fig. 13. Marking Width with Straight-edge

the original edge is fairly straight, thumb-gaging is resorted to. Where the edge is not straight two measurements for width are made, one at each end of that part of the board to be removed, and a straight-edge used to connect these. Length in either case will be measured from the end of the board, leaving enough margin to allow for checks at the end of the board; and the try-square or framing square and pencil are used to draw a line straight across the board.

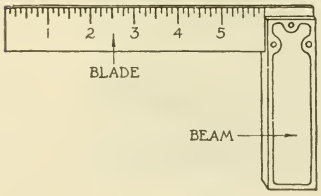


Fig. 14. Try-square

6. The Try-Square.— The try-square, Fig. 14, is used for three purposes in general, first, to act as a guide in laying out lines across the grain of a piece of stock,

Fig. 15. Lining Across the Grain

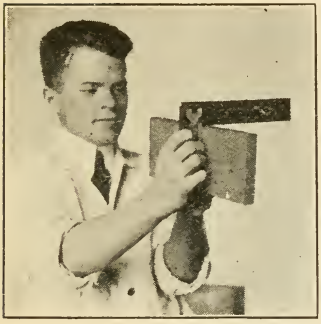


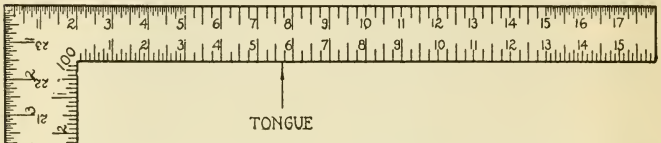
Fig. 16. Testing Edge for Squareness

Fig. 17. Testing End for Squareness

Fig. 18. Additional Test of End

Fig. 19. Test for Uniformity of Width

Fig. 15; second, to test the edges, Fig. 16, or ends, Figs. 17 and 18, of a board to see if they make right angles, or are square with the faces; third, to test a piece of stock by sliding the square along it with the eye fixed upon the



graduations at the far edge to see whether any change takes place as the square is pushed along, Fig. 19.

7. The Framing Square.—The framing square, Fig. 20, will be found useful about a shop where the try-square is too small. It is of very great value to the carpenter in the framing of houses and barns, etc.

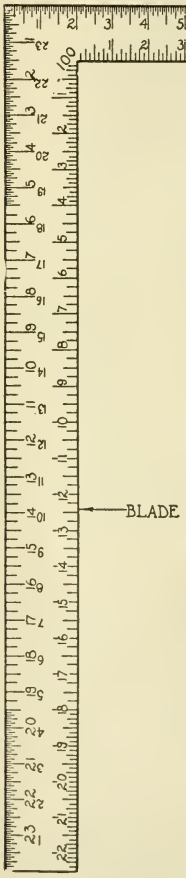


Fig. 20. Framing Square

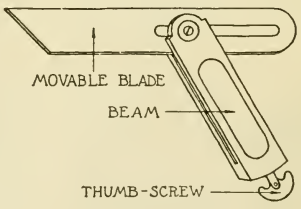


Fig. 21. Bevel

8. The Bevel.— The bevel, Fig. 21, is nothing more than a try-square with a movable blade and a thumb-screw which will hold the blade at any desired angle with reference to the beam.

9. The Marking Gage.— The marking gage, Fig. 22, is used for laying out accurate lines along the grain of the wood.

The spur, or marking point, is to be sharpened like a knife point by means of a file, the cutting edge to act when the gage is pushed forward with the right hand. A left handed person will have to draw the gage toward him or else reverse the cutting edge of the spur.

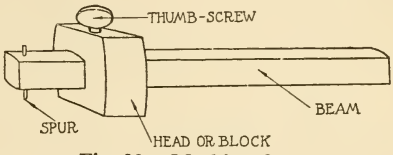


Fig. 22. Marking Gage

As the graduations on a gage stick or beam are not reliable, it is safer to set a gage by means of a rule held

Fig. 23. Setting Marking Gage

as in Fig. 23. As in all other work, make certain of the accuracy of the setting by again measuring with the rule after the thumb-screw has been adjusted for the first setting. Measure from the gage head to the sharpened point of the spur.

10. The Dividers.— A good pencil compass will be found better for elementary woodwork than the dividers, Fig. 24, because they do not scratch the wood. Car-

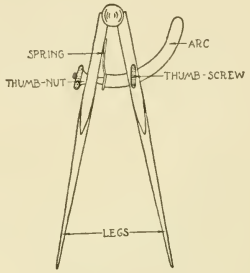


Fig. 24. Dividers

penters, however, find much use for dividers. Some dividers are made with one leg removable with an adjustment such that a pencil may be substituted. Dividers, like compasses, are used in describing circles or arcs.

CHAPTER III

Saws; Their Uses

11. Hand or Crosscut-Saw, and Rip-Saw. Saws, as determined by their teeth, are of two general classes — crosscut and rip. The former class are used for cutting

Fig. 25. Effect of Chiseling Along the Grain

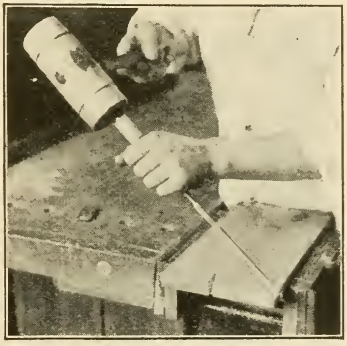


Fig. 26. Effect of Chiseling Across the Grain

across the grain, the latter for separating the fibers along the grain.

An examination of Figs. 25 and 26 will indicate the necessity for differently shaped teeth for saws cutting across and along the grain. The rip-saw has the cutting edges of its teeth across the front of the teeth, and is in fact nothing more nor less than a lot of little chisels,

cutting in rapid succession as the blade is pushed forward, Fig. 27. The handsaw or crosscut-saw is like the rip-saw in all respects except that the cutting edges of the teeth must be on the sides rather than across the front of the teeth, Fig. 28. Try the experiment of trying to cut a kerf across the grain by holding the chisel as in cutting along the grain, the reason for shaping the teeth with the cutting edges on the sides of the teeth will readily be seen.

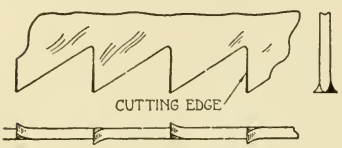


Fig. 27. Teeth of Rip-saw

12. Sawing with Hand or Crosscut-Saw and with Rip-Saw.—In using these saws, generally the board to be sawed will be placed upon a pair of trestles or "sawhorses." Place the knee upon the board and assume a position for ripping similar to that shown in Fig. 29. The index finger of the right hand should extend along the side of the saw to assist in guiding it; place the thumb of the left hand upon the board at the place the cut is to be made and the blade of the saw against the thumb

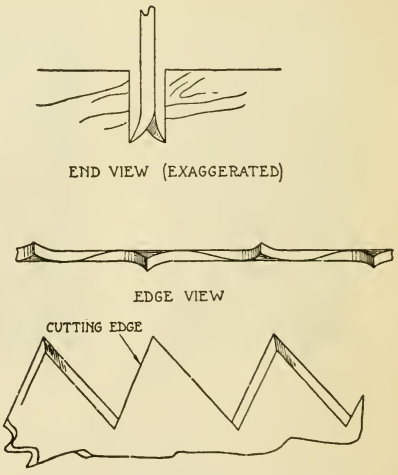


Fig. 28. Teeth of Crosscut-saw

lightly. Holding the cutting edge at an angle of about 60 degrees with reference to the surface of the board, begin the sawing with short, light, easy strokes, gradually increasing their length as the kerf is formed, until almost the full length of the saw is used. Strive to keep the eyes, hand, and saw blade in one and the same plane. Should it become necessary to change the direction of the saw because of its not following the line properly, this can be done by gently twisting the blade as the sawing proceeds in the direction it should take. This twisting must be done with care or the blade will bind and kink. When nearing the finish of a kerf, shorten the length of stroke and lighten the weight of the saw by holding up on it, at the same time taking hold of the part being cut off, Fig. 30.

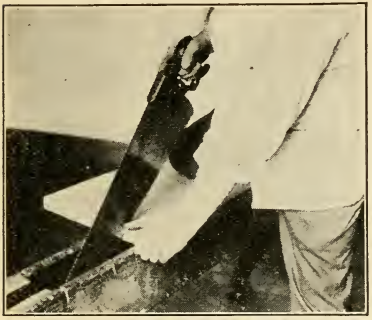


Fig. 29. Position for Ripping

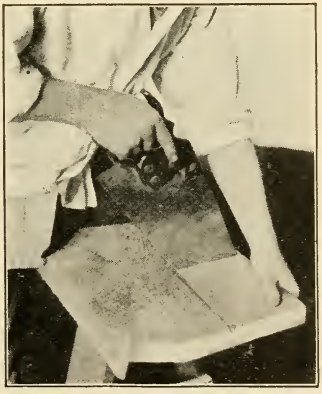


Fig. 30. Position for Final Crosscutting

In cutting a piece from a large board, rip-saw first

and then crosscut to meet the ripped kerf, thus leaving on the main board all but just what is wanted. This practice is more economical and is less likely to result in a split piece.

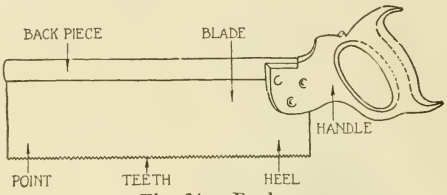


Fig. 31. Back-saw

13. The Back-Saw.— The back-saw, Fig. 31, is used for both ripping and crosscutting upon fine work. The blade is made quite thin and is reinforced by means of a back piece.

The handsaw or crosscut-saw and the rip-saw are used mainly upon coarser work such as the cutting out of stock. In such a case the penciled lines are placed so as to lay out the piece somewhat wider and longer than the dimensions desired for the finished piece. Here the saw is placed so as to "straddle" the penciled line. In accurate sawing, as with a back-saw, a knife line is used, being placed at the exact location desired for the finished piece. The saw blade is then placed so as to bring the kerf entirely upon the waste wood, but with no wood left between the kerf and line, Fig. 32. The proper starting positions for the back-saw are shown

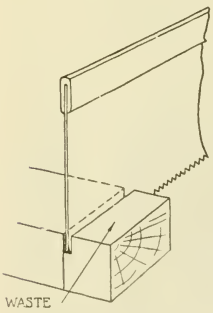


Fig. 32. Accurate Sawing to Line

in Figs. 33 and 34. Upon a narrow piece the saw may be started from one side only, usually the far side. As with the other saws, the beginning strokes are short,

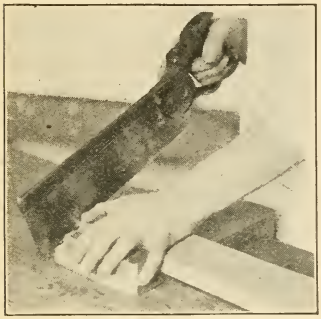


Fig. 33. Starting Position in Backsawing

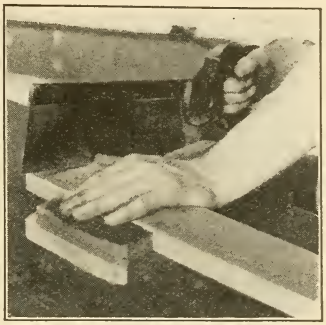


Fig. 34. Alternate Starting Position

light, easy ones, increasing in length as the sawing proceeds. The handle is gradually shifted as the newly formed kerf provides a guide for the blade, until the back is in a horizontal position.

In manual training work the back-saw is often used for rough cutting off of small stock, the kerf being made with reference to the knife line as in Fig. 35, the surplus stock remaining, being removed with a plane. In such sawing the stock should be placed flat side up, not edge up, a back-saw blade cannot be twisted as can the hand-saw and rip-saw to make it follow the line.

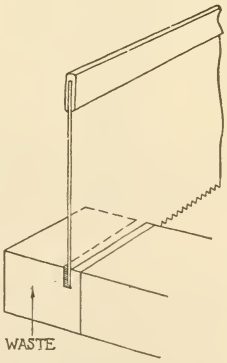


Fig. 35. Sawing Parallel to Line

CHAPTER IV

Planes; Their Adjustments; Face Side, Face Edge

14. Planes.— The planes shown in Figs. 36–39 are those most used in ordinary woodwork. Of these, the

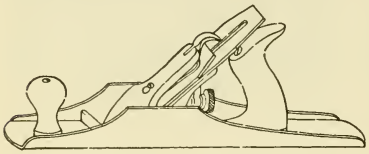


Fig. 36. Jack Plane

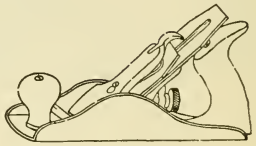


Fig. 37. Smooth Plane

jack-plane alone will suffice for grammar grade work, its iron being ground straight across then whetted very slightly rounding. Where a full set of planes is available, the jack-plane is used for taking off rather large

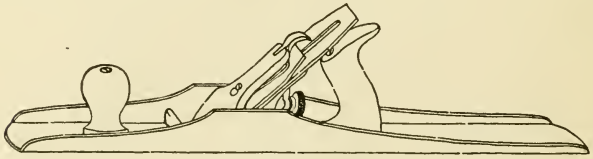


Fig. 38. Jointer

quantities, the blade being still more rounding than for manual training purposes.

The smooth-plane, Fig. 37, is also sometimes used in elementary manual training work. Its short length

makes it less suited for planing edges of 15″ and over. It is used by carpenters for smoothing, the blade being ground and whetted straight across with the corners slightly rounded.

The jointer, Fig. 38, is used mainly for planing edges of long boards, etc. The blade is ground and whetted straight across. The extra length keeps the blade from cutting the hollows until the high spots have been removed.

The block-plane, Fig. 39, is of especial advantage where a vise is not available for holding the stock, and one hand must be used to hold the stock while the other holds the plane. It differs from the other planes in that it has no cap-iron and in having the bevel of the plane-iron placed up instead of down. The mouth of this plane is adjustable, a small lever at the front of the plane being used for this purpose.

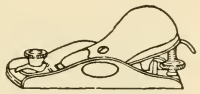


Fig. 39. Block Plane

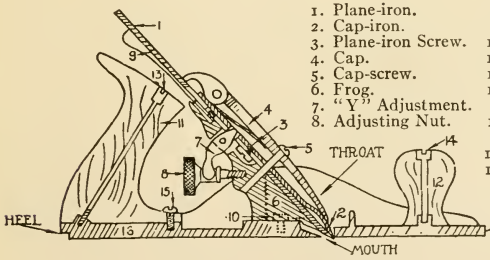


Fig. 40. Parts of a Standard Plane

15. Adjustments of a Standard Plane.— Fig. 40 names and locates the various parts of a modern plane.

Fig. 41 shows in detail the two irons of the plane, the plane-iron or plane-blade or bit and the cap-iron. The cap-iron acts as a shaving breaker. Were the grain of the wood the least unfavorable and such a shaving breaker not used, the plane-iron would cause the wood to split and break as shown in Fig. 41, lower figure.

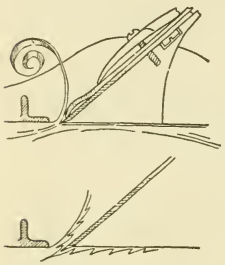


Fig. 41. Action With and Without Shaving Breaker

The sectional view, Fig. 40, shows the relative positions of plane-iron and cap-iron. The cutting edge of the plane-iron should extend about $\frac{1}{16}$ in. below that of the cap-iron for ordinary work. For fine work this distance may be lessened. Before the irons are placed in the plane the plane-iron screw must be made fast by means of a screwdriver or the plane cap.

After the irons are fastened together properly, they may be placed in the throat of the plane, plane-iron down and cap-iron up. Make certain the plane-iron rests flat upon the frog, with the Y-adjustment inserted in the slot made for it in the cap-iron. The cap may next be placed and its cam pushed down. Should it be impossible to force the cam into place without great pressure, first look to see that the plane-iron rests flat upon the frog with the Y-lever in its slot in the cap-iron. With beginners, this is the most frequent cause of a tight acting cam. Sometimes, however, a loose acting cap-screw will be the cause of either a tight or a loose acting cam. Once a cap-screw is adjusted, it seldom needs attention unless loose fitting. The cam should cause the cap to

press no tighter against the irons than is necessary to prevent their moving from side to side in the throat of the plane when tested with the fingers.

In adjusting a plane-iron for depth of cut, hold the plane as in Fig. 42, looking toward the light. Sight along the plane bottom, at the same time turning the brass adjusting nut until the cutting edge projects very slightly, not much more than the thickness of a piece of drawing paper. A shallow set plane-iron resulting in "tissue paper" shavings will enable one to secure good results quicker than any other kind of a setting. Where the wood is rough sawed, a carpenter, it is true, will set the iron slightly deeper, but he invariably sets it shallower as soon as he has removed this surplus stock. A second adjustment consists in moving the lateral adjusting lever, while sighting along the bottom of the plane toward the light, until the cutting edge of the iron shall project evenly.

Fig. 42. Sighting a Plane-iron

16. Face Side, Face Edge.— The first surface — a broad surface, should the piece not be square in section, and the first edge selected or prepared have a special use and are given distinguishing names. The first sur-

face is known as a face side or working face, and the first edge is known as a face edge or joint edge. They are marked as indicated in Fig. 43, the marks being made near the middle of the length of the piece, so that they may be distinguished from the other surfaces, which are not marked. From these two marked surfaces all testing, as described later, is done, the head of the gage

Fig. 43. Face Side; Face Edge

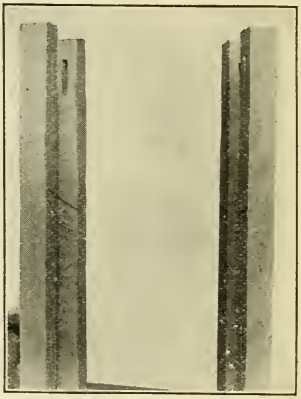


Fig. 44. Faces Turned In

and the beam of the try-square being held against these and these only. To do otherwise is to introduce additional chances for errors.

Where the project is to consist of but one member, the better broad surface and the better edge are selected for face side and face edge. Frequently it is difficult to decide which is the better surface or edge. Usually, however, streaks of sapwood, or small knots, or checks appear more numerous upon one surface than the other.

Where several members are to be joined together to form a project, such as a table or chair, it is best to so select the faces that they may be turned in when the members are put together, Fig. 44. Faces are more likely to be accurately made than are the reverse surfaces and, for this reason, the joints are more likely to fit properly if the faces are placed so that the mortises or joints may be made in them. This would mean, of course, that the surfaces selected for faces should be the poorer rather than the good surfaces as in the case of the single piece project.

CHAPTER V

Squaring-up Stock

17. Mill-Marks.— Before the time of woodworking machines, such as we have to-day, it was customary to surface or plane the broad surfaces by hand, as will be described later in this chapter. To-day, woodworkers

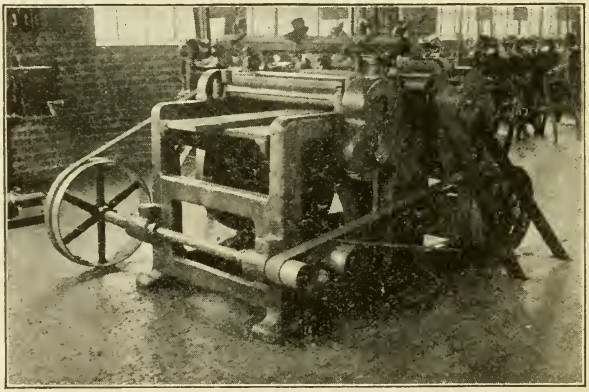


Fig. 45. Surfacing Machine

may go to any lumber yard and get stock, machine planed upon the two broad surfaces to stock thicknesses. Such surfaces are sufficiently smooth or level and the thicknesses sufficiently uniform for much woodwork, especially in carpentry, so that the process of squaring up the stock, which means making the edges, surfaces, and ends at

right angles to a face side or a face edge, is greatly simplified.

Fig. 45 is an illustration of a machine used to plane broad surfaces of boards. This machine has long knives attached to a revolving cylinder extending across the bed. As the board is made to travel over the bed by an automatic feed, these knives, revolving at a speed of 3,500 to 3,800 revolutions per minute, remove chips entirely across the board. Where the board is fed over the table slowly, thus giving the knives plenty of time for action on a given place, it is difficult for a beginner to tell a machine planed board from one that is hand planed. The little ridges and hollows across the machine planed board are there, however, and must be removed with the hand plane, where a stain or filler is to be applied later. If this is not done, every ridge and hollow will be made to stand out prominently when the stain is applied.

18. Methods of Squaring-up Stock.— For the sake of convenience we may classify the methods of squaring-up stock under the following heads; squaring-up mill-planed stock for (1) outside finish; (2) inside finish; (3) squaring up rough-sawed stock or mill-planed stock where accuracy is very important. In reality there is but one method of squaring-up stock — number three — the others being modifications of the order for this.

The simplest process of squaring-up stock is that used in preparing stock for outside building finish, such as base, corner boards, cornice members, etc. For this purpose mill-planed stock is made use of, stock thicknesses being specified. Since such finish is usually painted, and, being on the outside, does not require a

fine treatment, nothing is done to the broad surfaces, not even planing off the mill-marks or sandpapering. Many manual training shop problems, such as cutting-boards, bird houses, etc., may be treated in this same manner.

A larger number of manual training projects will make use of the second method of squaring-up stock — that

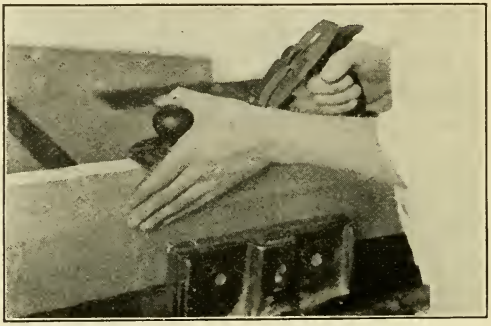


Fig. 46. Position in Edge Planing

used in preparing interior building finish. This differs from the one just described in that, being intended for inside work where the surfaces will be stained and waxed or varnished, the mill-marks must be removed from one or both broad surfaces, and these sandpapered well. Like outside finish, inside finish, too, does not require that its broad surfaces be perfectly true or out of wind, merely smooth. The reason stock slightly warped will answer for all exterior and most interior finish is due to the fact that most of the wind can be "nailed out" in assembling, Fig. 101.

Projects in furniture construction and in pattern-

making, however, do not as a rule have assemblies which permit of "nailing out" warp or wind. For this reason a third method, more difficult than those mentioned, is required in which the first surface must be made true, with warp and wind removed. A uniform thickness is gaged from this trued surface.

19. Squaring-up Mill-Planed Stock. *First Method:*

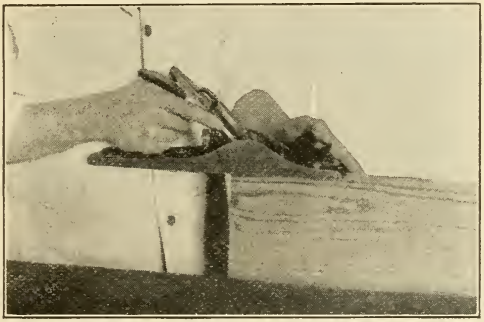


Fig. 47. Starting the Stroke

(1) Select and mark one of the broad surfaces for a face side, Fig. 43. (2) Select and plane a face edge (a) square to the face side and (b) straight as to length.

Place the piece in the vise and assume a position as in Fig. 46. Plane the edge straight as to its length and square to the face side just prepared. In elementary manual training the jack-plane will be used for this purpose. Press firmly upon the knob in starting the stroke, Fig. 47, and upon the handle at its close, Fig. 48; otherwise the ends will be lowered more than the middle of the board. In planing a long board it will be necessary to stop and start some of the strokes in the middle

of the length of the board. It is possible to do this without leaving any plane marks by lowering the plane gradually in starting and raising it gradually in stopping

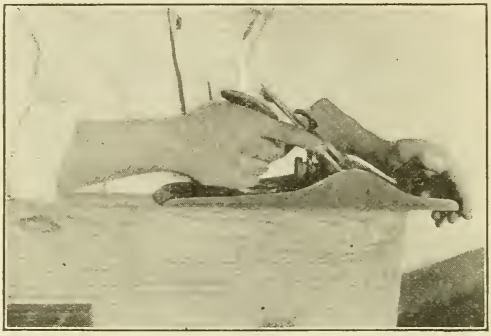


Fig. 48. Finishing the Stroke

Fig. 49. Sighting for Straightness

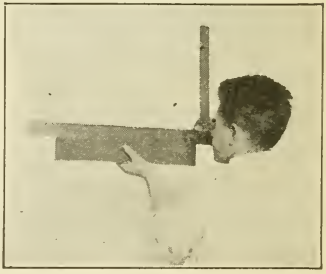


Fig. 50. Straight-edge Test

a stroke, getting what is known as a "feathered" shaving. Take off no more shavings than are necessary to secure the required straightness and squareness.

After the first stroke or two, hold the piece toward the light, as in Fig. 49, close one eye and sight for

straightness. The beginner will do well to make use of a straight-edge test, as in Fig. 50, until he has made sure he can "sight" correctly. No light should appear between the edge of the stock and the straight-edge when they are held between the eye and the light.

The second test, that for squareness of the edge, is made by holding the try-square as in Fig. 16 and sighting toward the light. Hold the beam firmly against the face side and test at a sufficient number of places along the edge to determine what the true condition is.

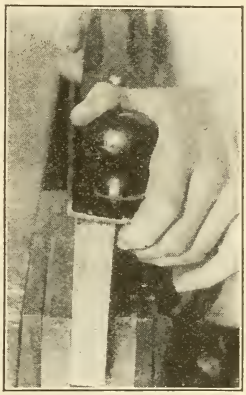


Fig. 51. Removing a High Arris

In edge planing the beginner should remember that his plane-iron is slightly rounding on its cutting edge, and that all he needs do to take a shaving at any given place is to continue holding the plane level but move the whole plane body over until the rounded central part of the cutter is immediately over the "high" place on the stock. Fig. 51 shows the plane placed to take a shaving off the edge at the arris nearest the worker. The final stroke should be taken the full length of the stock and down the middle of the edge that any slight unevenness resulting from partial strokes may be removed.

Place the face mark on this edge when it meets the required tests, marking it as in Fig. 43.

(3) Plane the second edge (a) square to the face side, (b) straight as to its length and (c) parallel to the face edge.

Where a definite and exact width of board is required, a line is gaged from the face edge by means of a marking gage set as in Fig. 23 and held as in Fig. 52 with the head against the face edge. The line should be lightly made and the planing continued until half of the light V-shaped groove is removed. Test the edge for squareness frequently as the gage line is approached that the edge may be square when the line is reached. If the gage line is approached properly the edge should be straight and parallel to the face edge. It is well for the beginner to test this edge for straightness, and for width with the sliding try-square test.

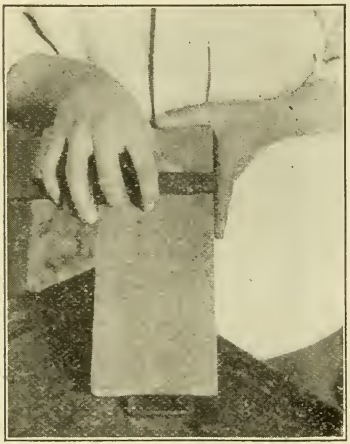


Fig. 52. Gaging

Where the waste stock is more than $\frac{3}{16}$ in. it should be ripped parallel to the gage line and about $\frac{1}{8}$ in. away from it.

If much stock is to be removed the plane-iron may be set so as to take heavy shavings. When nearing the gage line it should be set to take fine shavings.

Not infrequently, while no definite width is required, it is desired to have the second edge planed straight, square to the face side, and parallel to the face edge. In such a case, the worker simply planes the second

edge until it is straight, square, and meets the sliding try-square test illustrated in Fig. 19.

(4) Square up one of the ends (a) to the face side, (b) to the face edge. Ends may be finished in two ways: by sawing accurately to the line squared across from the face edge, Figs. 15 and 32; second, the end may be planed square. Ends sawed to make joints are usually "undercut" very slightly; that is, the sawing is done in such a way as to leave the face slightly longer than the back, thus insuring a fit on the face.

Fig. 53. End Planing; First Position

Fig. 54. End Planing; Second Position

In planing an end, the plane-iron should be very sharp and set very shallow and true. Test the end by holding the blade of the try-square across it with the beam against the face side and then the face edge, Figs. 17 and 18.

End planing differs from edge and surface planing in that the plane-iron must not be allowed to cut entirely

across the piece or the far edge will be broken off, Fig. 53. To avoid this, plane about two-thirds of the way across the end and then reverse the piece and plane from the other edge, Fig. 54. Test frequently as indicated above, and plane no more than is necessary to secure a result which meets the two tests indicated.

(5) Square up the second end (a) square to the face side, (b) square to the face edge. Where no definite length is required for the piece, the second end is merely

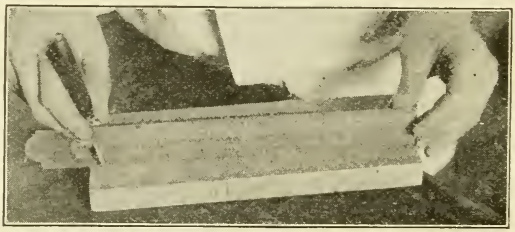


Fig. 55. Measuring Length

planed as was the first end, the same tests being applied. That is, the try-square is held with its blade across the end and its beam against the face side and then against the face edge, Figs. 17 and 18.

If the end is to be sawed square without planing, the try-square and pencil, or knife for accurate work, will be used to scribe a line across the face side and one edge, as in Fig. 15. The stock is then sawed as in Fig. 32.

Where a definite length of stock is prescribed, the rule should be placed as in Fig. 55, and the exact length marked. A line is scribed through this mark, Fig. 15, and the surplus stock either sawed exactly to the line where a sawed joint is to be made, or sawed about a

scant $\frac{1}{16}$ in. outside of the line where a perfectly smooth end is to be left. After this latter sawing, the $\frac{1}{16}$ in. surplus stock is removed with the plane.

Fig. 56. First Test for Surface Trueness

Fig. 57. Second Test for Surface Trueness

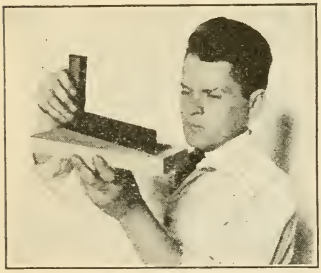


Fig. 58. Third Test for Surface Trueness

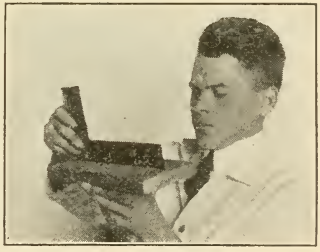


Fig. 59. Fourth Test for Surface Trueness

20. Squaring-up Mill-Planed Stock. *Second Method:* The only difference between the second method and the first method consists in the fact that the first broad surface, instead of simply having its face mark put on, must be planed smooth and free of mill marks. There is but one test for this surface, a test with the try-

square held as in Fig. 56 to see whether the board is straight across the grain, the test being made at a number of places along the board.

21. Squaring-up Rough Stock. *Third Method of Squaring Stock:* (1) True and smooth a broad surface for a face side, testing as in Figs. 56, 57, 58, 59. Put on the proper face mark, Fig. 43.

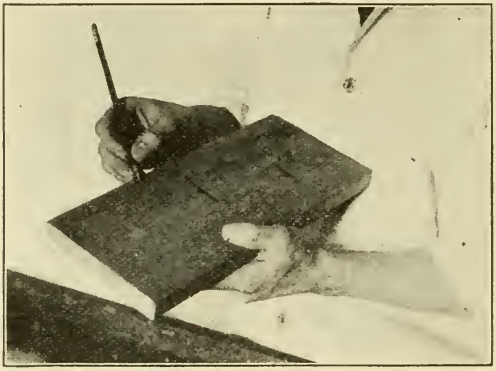


Fig. 60. Pencil Gaging for Chamfer

(2) Prepare a face edge in the usual manner, as described in connection with mill-planed stock.

(3) Gage to width from the face edge and plane to the gage line, as in mill-planed stock.

(4) Gage to thickness on both edges from face side. Plane to the gage lines, testing as in Fig. 56.

(5) Square one end in the usual manner, testing as in Figs. 17 and 18.

(6) Measure the required length and complete the second end as in mill-planed stock.

22. Planing a Chamfer.— Very frequently the arrises of a board are removed; the result produced is known as a chamfer. Chamfers are laid out with a pencil rather

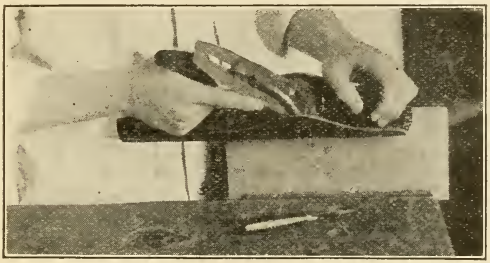


Fig. 61. Planing Chamfered Edges

than gage and try-square and knife. While the latter is more accurate the V-shaped grooves produced, spoil the appearance of the piece after the chamfering is

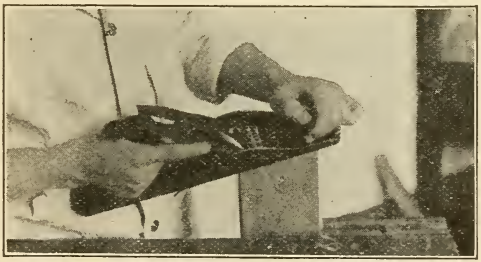


Fig. 62. Planing Chamfered Ends

completed to the lines. Hold the pencil as in Fig. 60, first having measured the required distance the chamfer is to be laid out from the arris. This method of laying out a chamfer is known as pencil gaging. The lines will

be laid off on edges, on ends, and on the surface at the two edges and two ends where the chamfer is to be placed, entirely around the piece of stock.

Holding the plane as in Fig. 61 plane the two arrises extending along the grain. Next, holding the plane as in Fig. 62, but moving it in a horizontal direction, plane the two end chamfers. By holding the plane as indicated in Fig. 62 a shearing cut is secured which, with the buttressed effect produced by planing the edge chamfers first, makes it possible to plane entirely across the end without splitting the far corner. In all cases where a plane is turned across the stock so as to secure a shearing cut, the plane should not be turned so far that the benefit of its length is lost as an aid to producing a straight surface.

As a rule, the eye will detect inaccuracies in a chamfer. If a further test is desired, Fig. 63 illustrates one.

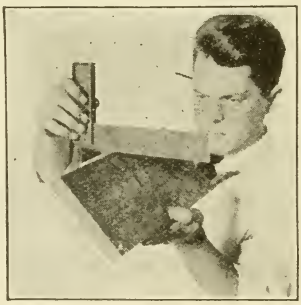


Fig. 63. Testing a Chamfer

CHAPTER VI

Boring Tools; Their Uses. Chisels and Chiseling

23. Brace or Bitstock.— The brace, Fig. 64, is used to hold various kinds of bits. A ratchet brace differs

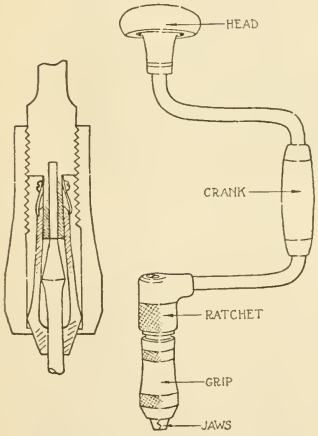


Fig. 64. Brace, or Bitstock

Fig. 65. Inserting a Bit

from the plain brace in that, by means of an adjustment, it can be made to turn in one direction or the other, as well as being made to act as a plain brace.

To insert a bit, hold the brace as in Fig. 65, revolving the crank to open and close the jaws.

24. The Auger-Bit.— The auger-bit, Fig. 68, is used for all ordinary work. The size of hole a bit will bore can be told by the number on its tang, which number is the numerator of a fraction whose denominator is 16 on

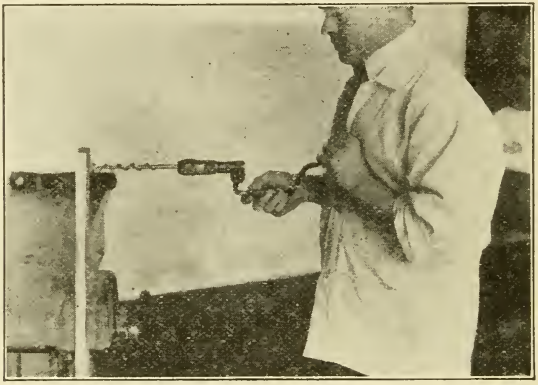


Fig. 66. Horizontal Boring; First Position

Fig. 67. Horizontal Boring; Second Position

auger-bits and 32 on drill bits. Sometimes the whole fraction is stamped on the shank or the tang.

In boring, stand so as to sight the brace and bit from two directions at right angles one to the other, Figs. 66,

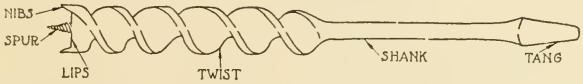


Fig. 68. Auger-bit

67, 69 and 70, swinging the upper part of the body from one position to the other as the boring proceeds.

Fig. 69. Vertical Boring; First Position

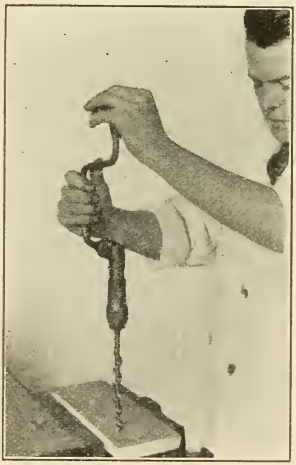


Fig. 70. Vertical Boring; Second Position

In boring to depth, a rule may be placed as in Fig. 71 as the lips begin to cut, and the boring continued until the measurement at the grip has diminished an amount equal to that desired for the depth of hole.

Where it is desired to bore entirely through a board, it is best to bore from the first side until the spur shows on the back, then reverse the piece and finish the boring from the reverse side, otherwise the nibs might split the wood on the reverse surface.

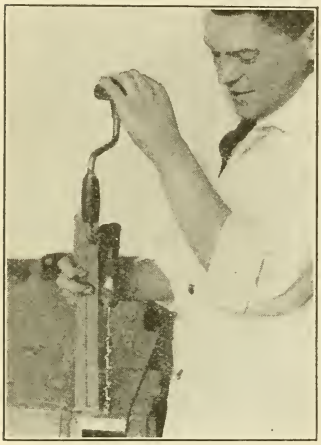


Fig. 71. Measuring Depth

25. The Drill Bit; Awls; the Gimlet Bit.—The drill bit, Fig. 72, is tempered quite hard and may be used to bore in metal as well as in wood. As this bit has no spur, it is best to make a "seat" for it. In metal a punch is used; in wood an awl, Fig. 73, will be used.

Gimlet bits, Fig. 74, are used mainly in boring small holes for screws.

The brad awl is used in making very small holes for

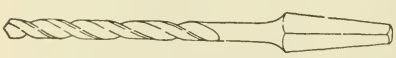


Fig. 72. Drill Bit

Fig. 73. Scribe Awl

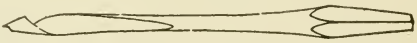


Fig. 74. Gimlet Bit

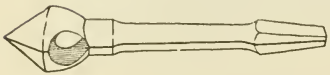


Fig. 75. Countersink Bit

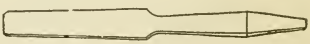


Fig. 76. Screwdriver Bit

small screws, but more especially for nails. It differs from the scribe awl only in that its extremity has a chisel edge instead of a point.

26. Countersink Bit; Screwdriver Bit.—The countersink bit, Fig. 75, is used to enlarge the holes bored for

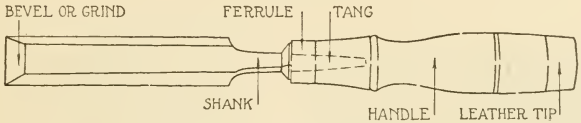


Fig. 77. Firmer Chisel

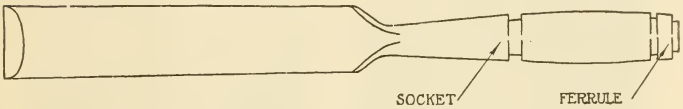


Fig. 78. Framing Chisel

the bodies or cores of flat-head screws, that the heads may be sunk slightly below the surface of the wood.

The screwdriver bit, Fig. 76, is used in connection with the brace for the rapid insertion of screws. To avoid the screwdriver bit's jumping out of the groove in the head of the screw, after each half turn of the crank, move the crank backward very slightly.

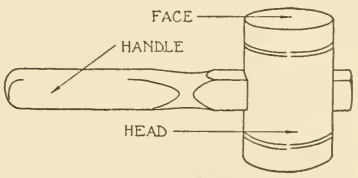


Fig. 79. Mallet

27. Chisels.—The two kinds of chisels most commonly used are the firmer chisel, Fig. 77, and the framing chisel, Fig. 78. The firmer chisel is lighter than the framing chisel and is used for fine work. The framing chisel is used where the work is such as to demand

pounding with a mallet, Fig. 79, to force its edge into the wood. The firmer chisel is usually fitted on a tang, though it may be fitted with a socket.

The size of a chisel is indicated by the width of the cutting edge.

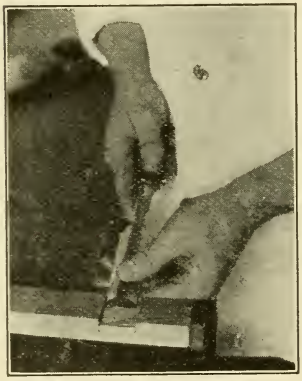


Fig. 80. Position of Hands, Horizontal Chiseling

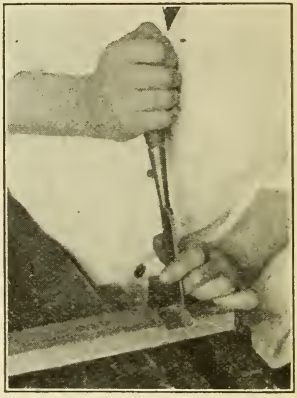


Fig. 81. Position of Hands, Vertical Chiseling

A chisel, to do good work, must be kept sharp. To avoid any chance for injury, both hands should at all times be kept back of the cutting edge, Figs. 80 and 81.

28. Chiseling.— In paring across the grain horizontally, place the piece of wood in a vise so that both hands may be free to manipulate the chisel, Fig. 80. With the bevel side of the chisel up, pare almost all the way across the piece, taking fairly large cuts at first, with thinner ones as the line is approached. Reverse the piece, and finish the cutting from the second side.

The sides of such a groove would be sawed first.

Where it is desired to trim or pare the sides of such a groove to make the groove wider, the chisel will be

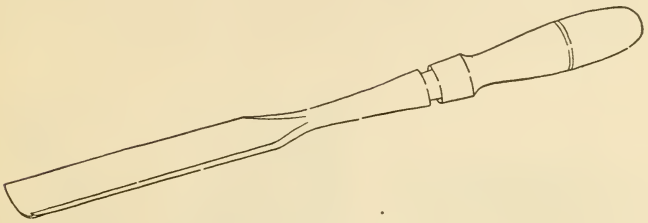


Fig. 82. Gouge

held as in Fig. 81, the worker standing so that he may sight along the line he is cutting. Very small portions are taken at a time, about $\frac{1}{8}$ in. of the blade being used

Fig. 83. Position of Hands, Heavy Cut

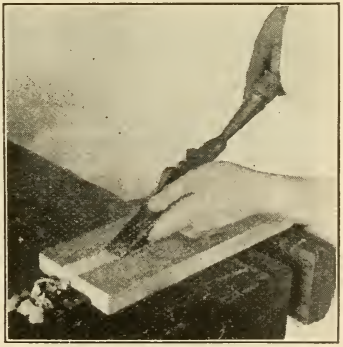


Fig. 84. Position of Hands, Light Cut

for cutting, the rest of the blade being held against the surface already pared. The movement of the handle is forward and downward to give what is known as a shearing cut, Fig. 81.

29. The Gouge.— The gouge, Fig. 82, which is a chisel of curved section, may have its bevel on either the inside or outside of the curved blade. Figs. 83 and 84 illustrate the manner of holding an outside beveled

Fig. 85. Grinding a Chisel

Fig. 86. Whetting a Chisel

Fig. 87. Starting Position in Whetting

gouge for taking heavy and light cuts. Gouges cut better when given a circular movement at the cutting edge as the tool is pushed forward.

30. Whetting Chisels and Plane Irons.— When edged tools become dulled through repeated whettings, or through being brought into contact with metal, they must be ground, Fig. 85. Grinding is a rather difficult task for beginners to learn to do well. Beginners ought, however, to learn to whet their edged tools.

Whetting consists in rubbing the tool backward and forward, Fig. 86, taking care to hold the tool at one and the same angle. This angle may be determined as follows: place a little oil on the stone, and placing the iron as in Fig. 87, gradually raise the handle until the oil can be seen to press out from under the cutting edge, Fig. 86. To raise the handle any higher would result in a blunt edge in whetting. Not to raise it high enough to expel the oil would result in the whetting being done at the heel of the bevel, which would do no good.

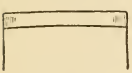


Fig. 88. Shape of Jack-plane Iron. Exaggerated.

Oil is used upon a whetstone to mix with and remove the little particles of steel which, otherwise, would clog the pores of the stone.

A chisel has its edge ground straight across. A plane iron for general manual training purposes is ground straight across but is whetted slightly rounded as in Fig. 88.

Fig. 89. First Stropping Position

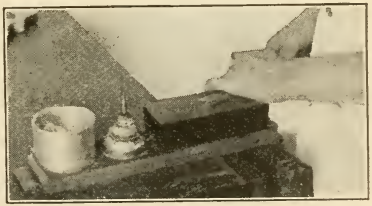


Fig. 90. Second Stropping Position

Whetting usually causes a wire edge to be turned up on the face of a chisel or plane-iron. This wire edge may be detected by rubbing the fingers along the face out

over the edge. To remove this edge, strop the tool upon a piece of leather upon which has been placed a slight coating of oil and emery dust. Hold the tool first as in Fig. 89, then as in Fig. 90, alternating rapidly from one position to the other as the stropping proceeds.

Fig. 91. Thumb-nail Test for Sharpness

Fig. 92. Mechanics' Test for Sharpness

There are a number of ways of telling whether an edge is sharp or not. One way is to draw the edge over the thumb-nail as in Fig. 91. If the tool is sharp it can be felt "taking hold." If the edge is not sharp it will simply slide over the nail.

A more delicate test, the one used by carpenters, is to make the same kind of a test but using the ball of the thumb, Fig. 92. Judgment is required in this latter test or a cut thumb will be the result. Do not use a finger. The thumb is calloused and when the sharp edge "takes hold" it is cutting in this callous.

CHAPTER VII

Additional Tools and Appliances; Their Uses.

31. Sandpaper.— Sandpaper should be used only after the edged tools have completely finished their work. Sandpaper is intended merely as a means of

Fig. 93. Sandpapering Flat Surface

Fig. 94. Sandpapering Curved Surface

smoothing a surface, and any attempt to make it do the work of an edged tool will result in an unsatisfactory piece of work.

In sanding flat surfaces use a block, holding the paper with the fingers as indicated in Fig. 93, sanding along, not across, the grain of the wood. Curved surfaces will be sanded with the paper held free in the hand, as in Fig. 94.

On flat surfaces the arrises are kept sharp, unless upon the arm of a chair, or similar part, where the sharpness would cause injury or discomfort.

The relative fineness or coarseness of sandpaper can be told by the number stamped upon the back of each

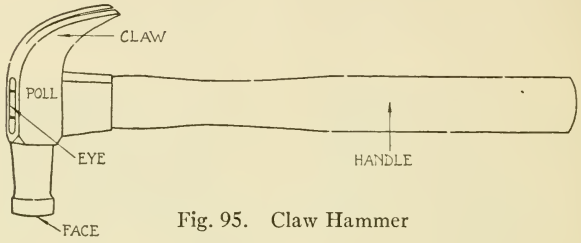


Fig. 95. Claw Hammer

sheet. These numbers vary from 00 to 2, the former being quite fine and used for sanding shellac and other finishes. No. 1 is most commonly used in manual training work.

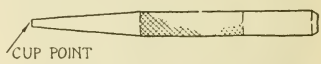


Fig. 96. Nailset

Never sandpaper the parts to a joint; the edged tools must be depended upon entirely for joint work.

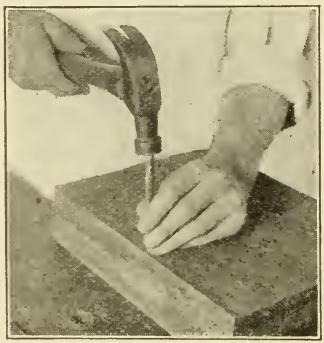


Fig. 97. Setting Nails

32. Hammer; Nailset. —The hammer most commonly used by woodworkers is what is known as a bell-faced claw hammer, Fig. 95. The face of this hammer is slightly rounded that it may be used in setting nails upon outside work where the depression left by the face of the hammer is not objectionable.

Upon inside work, and in cabinet work, a nailset, Fig. 96, will be used in setting nails. Such a set is held as in

Fig. 97, one of the fingers resting against its point and upon the surface of the wood at the same time, to prevent the set from jumping off the nail head when the blow is struck with the hammer. The head of the nail will be driven very slightly below the surface of the wood.

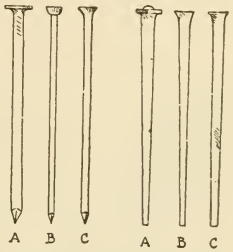


Fig. 98. Wire Nails

Fig. 99. Cut Nails

33. Nails; Nailing.— Nails used by woodworkers differ in shape or style according to their peculiar use. The most common type is the wire nail, Fig. 98. The cut nail, Fig. 99, is often used for fastening shingles as it does not rust as quickly as the wire nail. These nails are each classed as common, finishing, and casing nails, Figs. 98 and 99. Nails are sold by the pound and are roughly classified as to size by the term penny, as 3 penny, 6 penny, etc. A more accurate specification is one which indicates the gage of the wire as indicated upon a wire gage, Fig. 100, and the length of the nail in inches; thus, 1½″ No. 17 finishing nail. In determining the gage of a nail, it should be noted that the reading is obtained by fitting the slot of the wire gage, and not the hole to the body

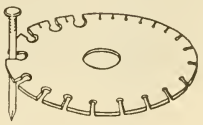


Fig. 100. Wire Gage

Fig. 101. Nailing

of the nail. The number at the slot which comes nearest fitting is the one which indicates the gage of the nail.

In nailing through one piece into the edge of another piece, the worker should stand so that he may sight along the second piece into which he is nailing, Fig. 101. It is customary to start one of the nails in the first piece so that its point just projects slightly through the reverse side, the board being placed upon a scrap block that the nail point may not injure the bench top. After this the first member is placed upon the second member as in Fig. 101 and the nail driven in.

Fig. 102. Withdrawing Nails

In nailing on box bottoms, care must be taken to so place the nails that they shall not strike nails previously

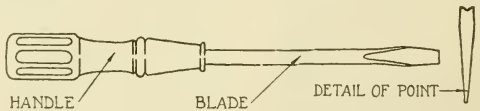


Fig. 103. Screwdriver.

driven through the sides into the ends or partitions of the box. Should a nail not take the desired direction, nothing is gained by striking it sidewise with the hammer in an effort to change its direction. This but serves to aggravate the difficulty by bending the nail in such a manner that it will "come out" sooner than it otherwise

would have done. Withdraw the nail and start it in a new location.

In withdrawing a nail, place a block of scrap wood under the head of the hammer to prevent its marring the wood, Fig. 102. If the nail is long, use several blocks of different thicknesses as the nail is withdrawn.

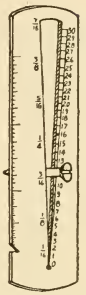


Fig. 104
Screw Gage in Use

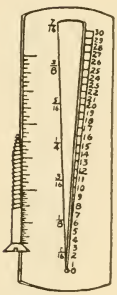


Fig. 105
Determining Length of Screw

34. The Screwdriver; Screws; Fastening with Screws.—In Fig. 103 is shown a common type of screwdriver. The end if shaped as shown will be found less likely to "jump out" of the groove in the head of the screw, resulting in a marred surface on the wood.

Screws used in woodwork are of two kinds: round-head and flat-head, either bright or blued steel, or brass. They are made entirely by machines and are put up in pasteboard boxes and sold by the gross. The size of a screw is designated by its screw gage and its length in inches. Fig. 104 shows the manner of placing a screw in the screw gage to determine its gage. Fig. 105 shows the manner of determining its length.

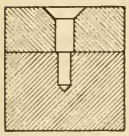


Fig. 106.
Holes Bored in Hard Wood for Screw

When fastening two pieces of hardwood together, holes will have to be bored in both lower and upper piece as shown in Fig. 106. This illustration shows the screw hole in the upper member countersunk ready to receive a flat-head screw. Round-head screws require no

countersinking. Upon soft wood the hole in the lower member is not necessary.

Fig. 107. Glue Pot

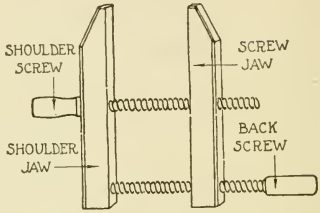


Fig. 108. Hand Clamp

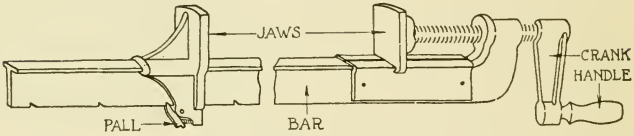


Fig. 109. Bar Clamp

35. Glue; Clamps.— Cabinet-makers use glue instead of nails for fastening parts together. Glue is made from the strippings of hide, from horns, hoofs, etc., of animals. These are boiled to a jelly-like consistency and chemically treated to give a clear color, and remove the disagreeable odor. As glue liquifies very slowly, it must be heated in a double boiler, Fig. 107, the outer pot containing water.

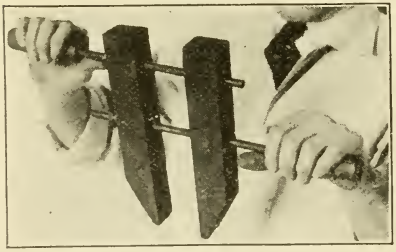


Fig. 110. Position for Adjusting Clamp

Glue is prepared by soaking it in water over night, then

applying a steady heat to the outer pot or kettle. Water is added as the glue cooks until the glue has a consistency which will flow freely when applied with a brush.

Fig. 111. Spokeshave

Clamps are used to expel the surplus glue from between the parts being glued together. Two kinds are in common use, the hand-clamp, Fig. 108, and the bar-clamp, Fig. 109.

In placing the hand-clamp, see that the jaws are kept parallel, adjusting by rotating the clamp as in Fig. 110. Tighten the back spindle last.

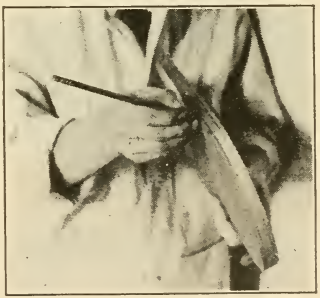


Fig. 112. Gaging Chamfers for Curved Edge

36. The Spokeshave; Working Curved Edges.— The spokeshave, Fig. 111, is practically a short plane, and like the plane should be adjusted so that it will remove thin shavings. It is used chiefly upon curved surface work and may be either pushed or pulled.

To make a curved edge upon the edge of a board, pencil gage lines on each of the broad surfaces which shall indicate the amount of curvature. Next, on the edge, pencil gage two lines each a distance from an edge

equal to one-fourth the thickness of the piece, Fig. 112. Spokeshave or, if the edge is straight, plane off the two arrises so as to leave three surfaces, the central one being the broader. Next, estimating the amount with the eye, remove the two central arrises until five equal surfaces have been formed. Holding the sandpaper as in Fig. 94, sand along the grain until a smooth curve is formed.

CHAPTER VIII

Simple Joinery

37. Joinery; General Directions.— The term joinery as used herein refers merely to the fitting together of two or more parts called the members. Take into consideration the direction of the grain in planning the relative positions of the members. Make due allowance where shrinkage is likely to be considerable.

As far as possible, plan to have the members join face to face. Face sides are more likely to be true than are the other two surfaces and therefore the joints are more likely to fit properly.

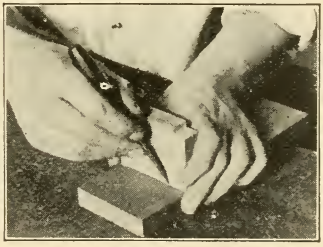


Fig. 113. Locating by Superposition

Make all measurements from a common starting point, as far as practicable. Remember to keep the head of the gage and the beam of the try-square against one or the other of the faces, unless there should be special reasons for doing otherwise.

In practice it is sometimes advisable to locate the sides of a joint by superposition rather than by measurement. Laying out by superposition consists in placing one member upon another and marking upon the second member

the width, thickness or length of the first. Fig. 113. Usually, it is found possible to locate and square with knife and try-square a line to represent one of the sides of the joint. The first member is then held so that one of its arrises rests upon this line, and a point is made with knife at the other arris. The superimposed piece is then removed and a line made with knife and try-square through the mark of the knife point.

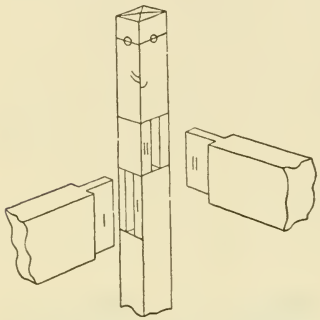


Fig. 114. Members Marked after Fitting

Where several members or parts are to be laid out, cut and fitted, it is of the utmost importance that the work be done systematically. System and power to visualize — that is, to see things in their proper relation to one another in the finished piece — make it possible for men to lay out and cut the members of the most intricate frames of buildings before a single part has been put together. Where several joints of a similar size and kind are to be fitted, mark the different parts to each joint with the same number or letter as soon as fitted, that no other member may be fitted to either of these. Fig. 114. On small pieces, such as the stool, it is possible to aid in visualizing by setting up the posts in the positions they are to occupy relative to one another, marking roughly, as with a pencil circle, the approximate location of the mortises, auger holes, etc. Fig. 115. The members may then be

laid on the bench and accurately marked without danger of misplacing the openings.

While the knife is used almost exclusively in laying out joints, there are a few instances in which a pencil, if well sharpened and used with slight pressure is preferable. To illustrate, suppose it is desired to locate the ends of the mortises in the posts. Fig. 114. To knife entirely across the surfaces of the four pieces and around the sides of each, as would be necessary to locate the ends of the mortises, would injure the surfaces. Instead, pencil these lines and gage between the pencil lines. Those parts of the pencil lines enclosed by the gage lines — the ends of the mortises — may then be knifed, if desired, to assist in placing the chisel for the final cut.

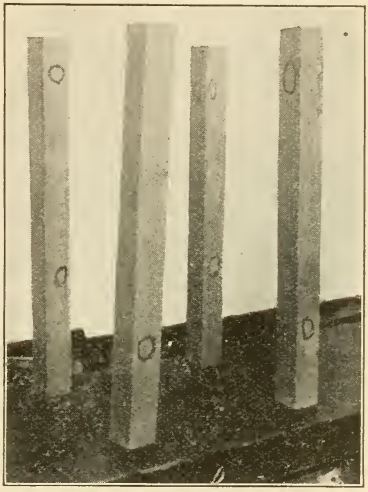


Fig. 115. Location of Joints Roughly Marked

In sawing joints in hard wood, the saw should be made to cut accurately to the line. When working soft wood, beginners are often permitted to leave a small margin — about one thirty-second of an inch — between the knife line and the saw kerf. This margin is afterward pared away with the chisel.

In assembling framework and the like, where it is

necessary to drive the parts together, always place a block of wood upon the member to be pounded to take the indentations that will be made. A mallet is preferable to a hammer for such pounding.

Frequently a piece of work will require the making of two or more like parts. To lay out these parts, that is, to mark out the location of intended gains, mortises,

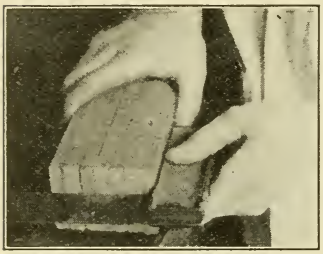


Fig. 116. Making Ends Even

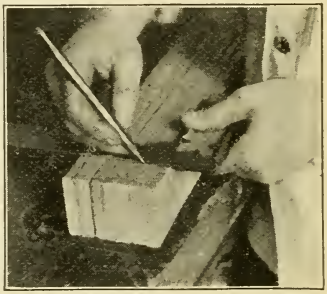


Fig. 117. Marking Duplicate Lengths

shoulders of tenons, etc., so that all shall be alike, the following method is used: (1) On the face edge of one of the pieces measure off with the rule and mark with knife the points at which the lines for the joints are to be squared across. If knife marks would show on the finished surface as scratches, use a sharp pencil instead. (2) Lay the pieces on the bench top with the face edges up; even the ends with the try-square. Figs. 116 and 117. Square lines across the edges of all of them at the points previously marked on one of them. The pieces may then be separated and lines corresponding to the lines just made on the face edges be carried across

the face sides of each piece separately, the try-square beam being held against the face edge in so doing, of course.

In all duplicate work the aim of the worker should be to make as much use as possible of the tool he has in hand before laying it down and taking another. To illustrate, if there should be a number of like parts, each requiring two different settings of the gage, he should mark all of the parts at the first setting, then all at the

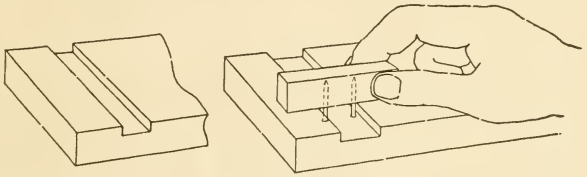


Fig. 118. Testing Dado for Depth

second setting, rather than to change the gage for each piece so that each piece might be completely marked before another is begun.

38. Directions for Making a Dado.— A dado, Fig. 118, is made by cutting a rectangular groove entirely across one member into which the end of another member fits. Dadoes are cut across the grain of the wood; when similar openings are cut parallel to the grain, they are called simply grooves. Dadoes are used in the making of shelving, window and door frames, etc.

(1) Locate by means of the rule one side of the dado and mark its position with the point of the knife. (2) At this point, square a sharp line across the piece with knife and try-square. (3) By superposition, locate and mark the second side. (4) Square these lines across

the edges of the piece a distance equal to the approximate depth of the dado. (5) Set the gage for the required depth and gage between the knife lines on the two edges. (6) Saw just far enough inside the knife lines that the sides of the dado may be finished to the lines with the chisel. Saw down just to the gage lines, watching both edges that the kerfs be not made too deep. (7) Chisel out the waste until the bottom of the dado is smooth and true. Test the bottom as shown in Fig. 118. Two

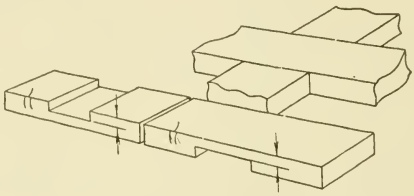


Fig. 119. Cross-lap Joint

brads are driven into a block having a straight edge until they project a distance equal to the proposed depth of the dado. (8) Pare the sides of the dado to the knife lines. These sides might be finished in another way, by setting a wide chisel in the knife line and tapping it gently with a mallet. If care is taken the successive settings of the chisel need not show.

Where the dado is to be cut on a piece narrow enough that the saw may be made to follow the line accurately, it is considered better practice to saw accurately to the line.

39. Cross-lap Joint.—Usually, stock for the two members of the cross-lap joint can be best planed to width and thickness in one piece. Place two sets of face marks on the piece, so that there shall be one set of

marks on each member after they are separated. Fig. 119.

40. Directions for Cross-lap Joint.— (1) Square the two ends, measure from each of these the desired length of each member, square knife lines around, saw apart, finishing the ends square to the lines. (2) Measure from one end of each member the required distance to the nearer edge of the joint. Since the corresponding faces of the two members must be on the same side of the piece when the parts are put together, it will be necessary to lay off the groove of one member on the face and of the other member on the side opposite the face. If the joints are to be in the middle of each member but one measurement need be made. (3) Square sharp knife lines across at these points. (4) By superposition, locate and knife the second edge of each joint. (5) If the joints are to be in the middle of each member, before proceeding farther, test to see that the lines have been laid out properly. If the members are placed side by side and the

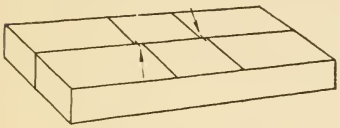


Fig. 120. Testing for Like Dimensions

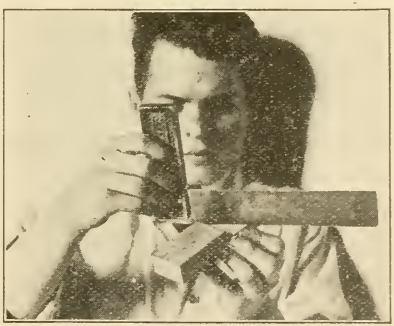


Fig. 121. Testing Bottom of Joint

ends evened as in laying out in (2) above, the lines will of necessity correspond. Turn one of the members end for end and even the two ends; the lines ought still to correspond. If they do not, points marked midway between the corresponding lines will give the correct position for the new lines, Fig. 120. (6) Extend the knife lines across the two adjoining surfaces of each member. (7) Set the

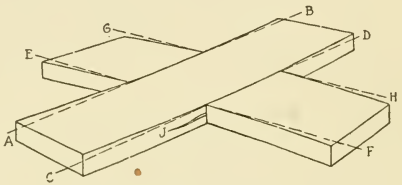


Fig. 122. Effect of Too Tight a Fit

gage for the required depth and gage between the knife lines on the surfaces. Though the groove on one member is laid out on the side opposite the face, do not make the mistake of holding the head of the gage against other than the face. (8) Saw accurately, Section 13, Fig. 32, to the knife lines and to a depth indicated by the gage lines. (9) Chisel out the waste stock, Section 38. (10) Test as shown in Fig. 121. A well-made cross-lap joint is one in which the members can be put together with the pressure of the hands and which will not fall apart of their own weight. Fig. 122 shows the results of "forcing a fit."

CHAPTER IX

Wood Finishing

41. Materials for Wood Finishing.— Finishes are applied to woods for two reasons, first, that the wood may be protected and, second, that its appearance may be bettered.

Of the materials used the following are the chief ones: Stain, filler, wax, varnishes, oil, and paint. These may be used singly or in combinations one with another or others in finishing.

Stains are used to give color to close grained woods. They are also used upon coarse grained woods before the application of a relatively darker filler.

Varnishes are of two kinds: spirit or alcohol and copal or oil varnish. The former, because of its rapid drying qualities is used mostly in manual training schools where dust abounds and no special finishing room free of dust and of even temperature is available.

Shellac or spirit varnish is a solution of lac and alcohol. Lac is soluble in both grain and wood alcohol but grain alcohol is preferable. Beds of crude lac are found in parts of Africa and South America where the lac has been left by the decay of leaves and twigs which it at one time encrusted. Crude lac is deposited upon leaves and twigs of certain of the lac-bearing trees by countless numbers of insects which draw out the sap.

Stick-lac is crude lac which has been purified some-

what of the bodies and eggs of the insects and rolled into stick forms. When crushed and washed it is known as seed-lac. When fully purified, which is done by melting and straining, it is spread out and is known as shellac.

White shellac is obtained by bleaching. Orange shellac is unbleached. Pure white shellac is used where the more yellow shellac would discolor. Orange shellac is stronger than white and will last longer but is harder to apply because it sets more rapidly.

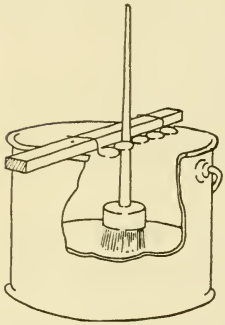


Fig. 123. Brush Holder

Shellac varnish sets quickly, dries hard, but softens under moisture. Unlike oil varnish, it does not "level up" and must, therefore, be brushed on quickly, using long, even strokes. No spots must be omitted for they cannot be "touched up."

Most of the above finishes are applied with a brush. The best brushes are made from bristles of the wild boar of Russia and China and are expensive. They should be well cared for, being cleaned when not in constant use. Brushes which have been used in filler, or paint, or oil varnish are cleansed with turpentine, or kerosene, or gasoline, or benzine. Brushes which have been used in shellac are cleansed with alcohol. Brushes which are used from day to day should be kept suspended over night in the liquid being used, so that their bristles shall not touch the bottom of the bucket, otherwise they lose their shape, Fig. 123.

Alcohol evaporates rapidly; shellac, therefore, should be kept in a receptacle which may have a top placed over it when not in use. White shellac is used for finishing light colored woods. It should be kept in a glass or stone jar, otherwise the metal will cause it to discolor.

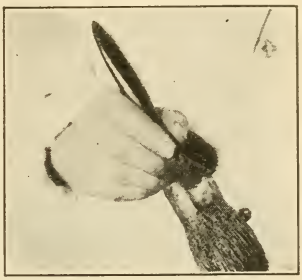


Fig. 124. Position of Hand on Brush

42. General Directions for Using Brush.—(1) Hold the brush as in Fig. 124. (2) Dip the end of the brush in the liquid to about one-third the length of the bristles. (3) Wipe off the surplus liquid on the edge of the can wiping both sides of the brush no more than is necessary to keep the liquid from dripping. A wire stretched across the can as in Fig. 125 provides a better wiping place for the dripping brush. In wiping the brush on the edge of the can, some of the liquid is likely to "run" down the outside. (4) Using the end of the brush, apply the liquid near one end of the surface to be covered. (5) "Brush" in the direction of the grain. (6) Work towards and out over the end of the board, leveling the liquid to a smooth film of uniform thinness. The strokes should be "feathered," that is, the brush should be lowered gradually at the beginning of the sweep and raised gradually at the close, otherwise, ugly "laps"

Fig. 125. Cleaning Wire

will result. The reason for working out over the ends rather than from them will appear with a little thought. (7) Now work toward the second end. The arrows, Fig. 126, show the general directions of the final or feathering strokes.

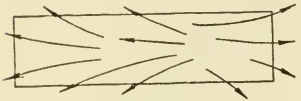


Fig. 126. Direction of Feathering Strokes

Edges are usually covered first and adjoining surfaces afterward.

It frequently happens that surplus liquid runs over a finished surface, especially when working near the arrises. This surplus can be "picked up" by wiping the brush upon the wire of the bucket until the bristles are quite free of liquid, and giving the part affected a feathering sweep.

If the object has an internal corner, work from that out over the neighboring surfaces.

Panels and sunk places should be covered first. Afterward, the raised places, such as stiles, rails, etc., may be attended to. Wherever possible the work should be laid flat so that the liquid may be flowed on horizontally. This is of especial advantage in varnishing. Vertical work should always be begun at the top and carried downward.

Tracing consists in working a liquid up to a given line but not over it, such as painting the sash of a window. Tracing requires a steady hand and some practice. A small brush is generally used and the stroke is made as nearly continuous as the flow of the liquid will allow, Fig. 127.

43. Simple Finishes for Close-Grained Woods.— It is taken for granted that commercially prepared finishes

are to be used; it is hardly profitable for boys to try to prepare their own stains and other finishes.

First Finish: (1) Remove all dust from the sanded surfaces. (2) Coat the piece to be finished with thin white shellac. (3) Allow this to stand over night; then sandpaper lightly with No. 00 paper held upon the tips of the fingers, Fig. 128. Sand just enough to remove the roughness of the shellaced surface. Do not use a block for the sandpaper; it is smoothness and not levelness that is required. It is too late to try to secure a level surface. (4) Apply a coat of prepared floor wax. These waxes are made to dry very rapidly. The directions for their application will be found printed upon the can labels. An easy way to remember these directions is to note that such waxes are applied and polished just as are the paste shoe polishes so generally used. (5) Polish this wax after it has stood some ten or fifteen minutes, using a flannel cloth. (6) After an hour another coat of wax may be applied and polished if desired. The more coats of wax the better the finish.

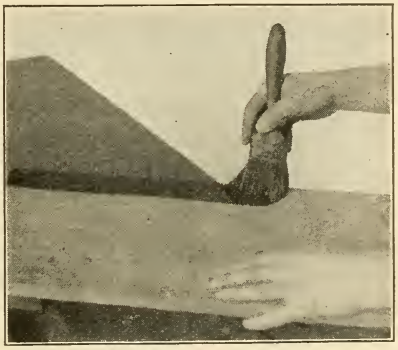


Fig. 127. Tracing

Second Finish: This finish is like the one just described, except that a coat of stain of the desired color is applied to the wood just before the thin coat of shellac.

Stains are of three kinds: water, oil, and spirit. Each has its advantages and its disadvantages. For simple manual training pieces, oil stains are recommended. Such stains are nothing more than paint thinned to proper consistency. Apply them with a brush, and immediately wipe the surface clear of the surplus material, using a cloth or piece of cotton waste. Make certain that all excess has been removed from corners

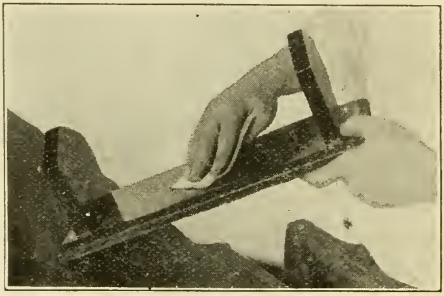


Fig. 128. Sanding a Finish

as well as surfaces, otherwise a muddied effect will result at the uncleaned places.

44. Simple Finishes for Coarse-grained Woods.— The finishing of coarse-grained woods differs from that of finishing close-grained woods chiefly in the means taken to "build up" the open grain of the coarse-grained woods to the same level as that of its close grain. This is accomplished by means of filler. Paste filler is usually made of ground rock crystal mixed with linseed oil, Japan drier, and turpentine. It may be either light or natural in color, or colored in any one of a number of shades.

First Finish: (1) Thin the filler with turpentine until it makes a thin paste. (2) With a stiff-bristled brush, force the filler into the pores of the wood and leave the surface covered with a thin coating. (3) Allow this to stand until the filler has "flatted," that is, until the "gloss" has disappeared and the filler becomes dull and chalkish. The time required for this to take place varies. Twenty minutes is not unusual. (4) Rub the filler off just as soon as it has flatted — do not let it stand longer, for the longer it stands the harder it is to remove. Rub across the grain as much as is possible, using a wad of excelsior. Finish fine work by going over it a second time with a cloth, rubbing with the grain as well as across, that the "high lights" may be clear of filler.

On fine work use a felt pad to rub the filler into the pores, and rub off with a cloth only.

Twenty-four hours should be allowed the filler to harden. One filling is sufficient for ordinary work; on fine work the above process is sometimes repeated after the first filling has hardened.

The striking contrasts in the grain of wood such as oak and chestnut, obtained by the use of colored fillers are due to the dark fillers remaining in the open grain but being wiped off of the close grain — the "high lights." (5) Apply a thin coat of shellac and allow it to dry over night. (6) Sand lightly with No. 00 paper held upon the finger tips. (7) Apply one or two coats of wax.

Second Method: The second method is similar to the one just described except that before the filler is applied

a coat of stain of a color desired for the "high lights", the close-grained spots, will be applied and allowed to dry over night. If water stain is used this will be sanded with No. 00 paper before the filler is applied. Next, the filler coat will be applied, a color of filler being used which is relatively darker but of the same shade as that of the stain being used. After this a thin coat of shellac is applied and the remaining steps taken as in the first method.

45. Painting.— The purpose of paints is to preserve the wood by covering it with an opaque material. Paints are usually composed of white lead and zinc oxide and coloring materials mixed or thinned with raw or boiled linseed oil. Turpentine is also used for thinning and as a drying agent.

Paint must be well brushed out so that a thin film may result.

In painting (1) Cover the knots with shellac, or the oil of the paint will be absorbed through two or three coats and a discoloration result. (2) Put on a prime coat. This coat should be mixed as thin as it can be and still not "run" when applied to vertical surfaces. (3) Fill the nail holes with putty. Sand lightly if a smooth finish is desired. (4) Apply two or three coats of paint thin enough to flow freely but thick enough to cover well and not "run."

The second coat is given a little more than the usual amount of turpentine that a "flat effect" may prepare the way for the final gloss coat. If the last coat is to be dull, turpentine is used in it as well as the second. Oil causes gloss, turpentine causes a dull or flat effect.

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